RR and MI Rings
Working Group Report

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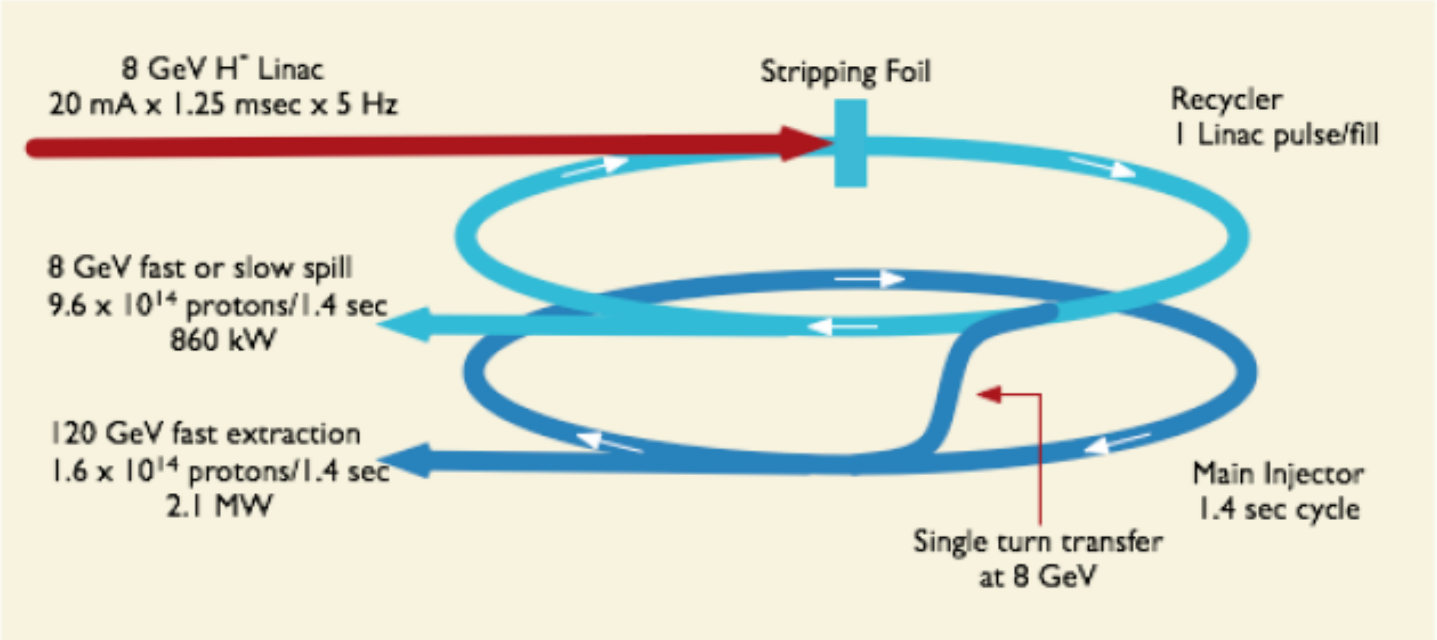
Project X Collaboration Meeting
September 11-12, 2009

Outline

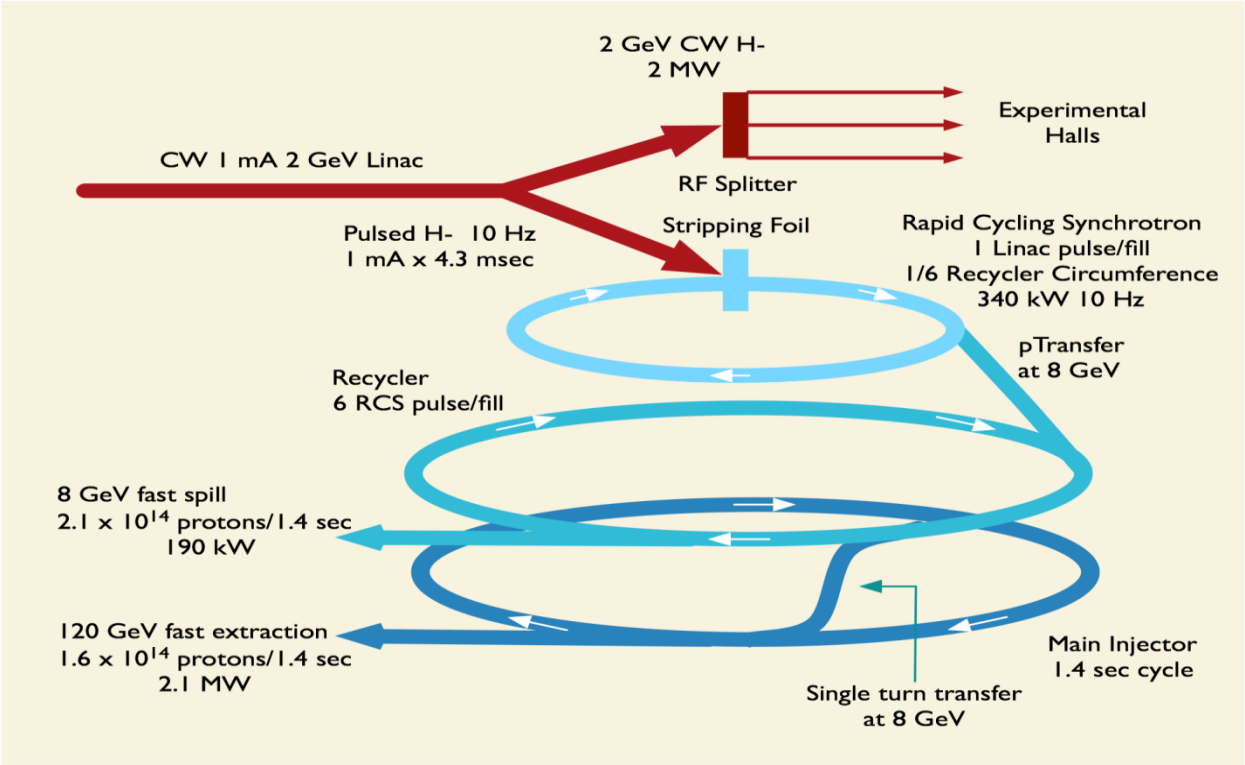
- Comparison between ICD-1 and ICD-2.
- Major R&D elements.
- Recent Progress.
- Tentative Plan for FY10.

ICD-1 Configuration



- 100 turns injection from Linac to RR
- Phase space painting in RR.
- One turn injection for RR to MI (bucket to bucket)

ICD-2 Configuration



- Bucket to bucket transfer from RCS to RR (six injections)
- One turn injection from RR to MI.

Major R&D Elements

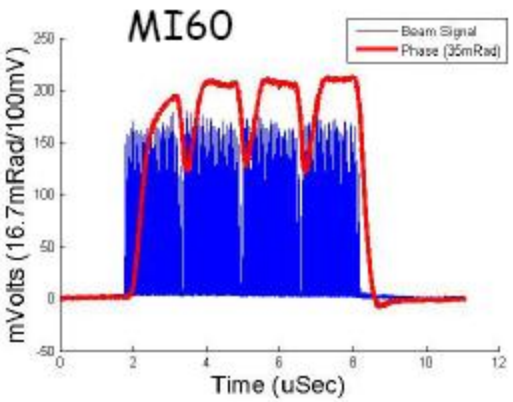
NO CHANGE BETWEEN ICD-1 AND ICD-2

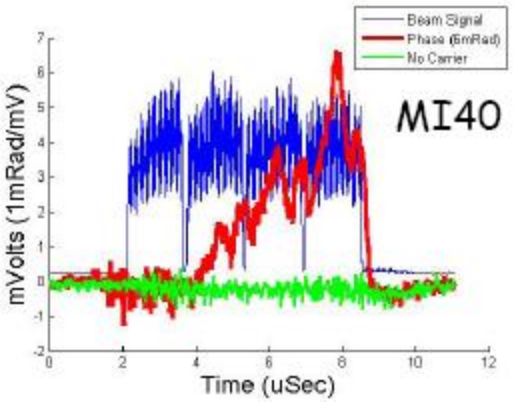
- The current MI rf system does not have enough power to accelerate the beam. We currently have no second harmonic system in MI. Need a 53MHz rf system (including a second harmonic) for RR.
- The MI crosses transition.
- Electron cloud instabilities and mitigation.
- Beam stability and losses in both MI and RR.

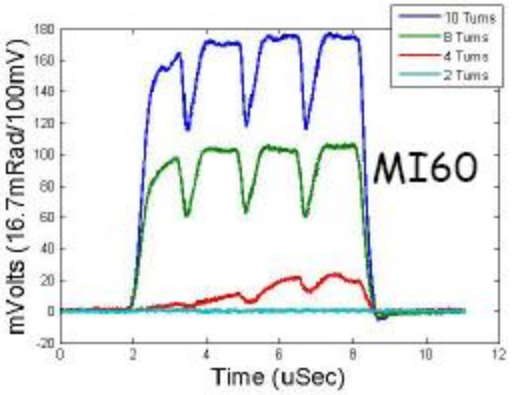
Recent Progress (1) E-Cloud Measurements

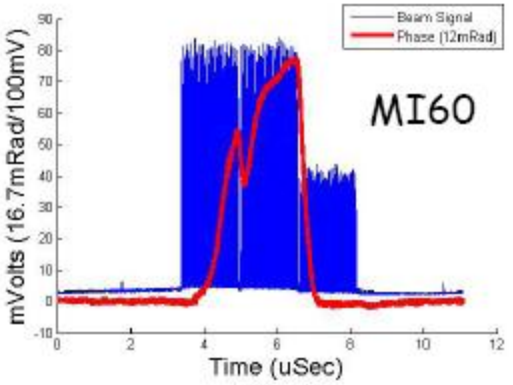
- Made great progress with e-cloud microwave measurements.
  - Data from both bend and field free regions.
  - Direct phase shift results.
  - Dedicated BPMs with good quality cables installed at MI-52 bend and MI40 straight sections.
  - 3 large aperture BPMs have been installed around the 3ft long test pipes at MI-52 for direct comparison with the RFAs.
- Developed and installed in the MI new improved RFA detectors.
  - Increased surface area.
  - Better focusing.
  - Fewer grids.
  - Installed a total of 3 new RFAs and 1 old one for comparison at MI-52 section

Direct Phase Shift results



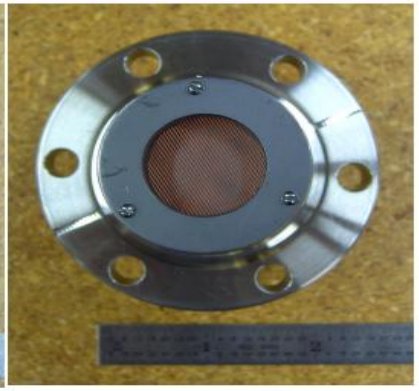




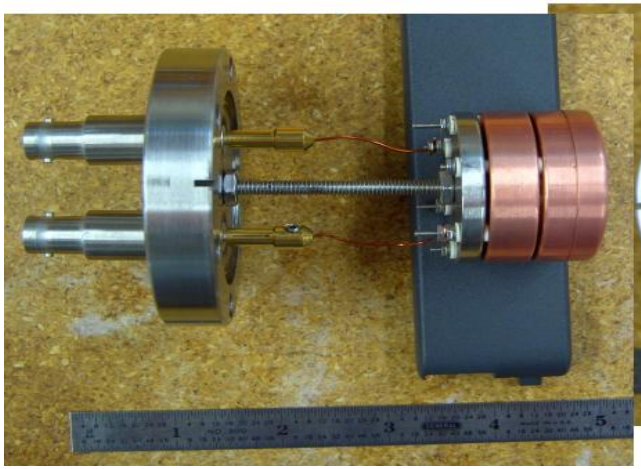


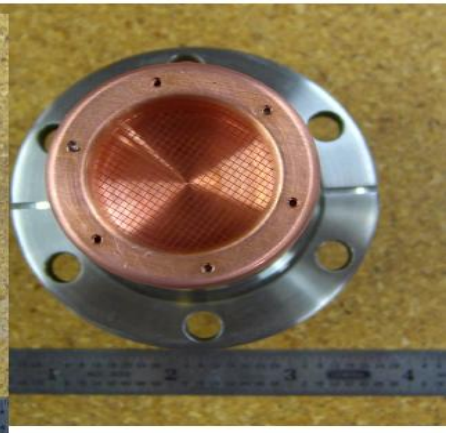
N. Eddy

New RFA detectors



Old RFA





New RFA

B. Zwaska, C.Y. Tan

Recent Progress (2)
E-Cloud Mitigation

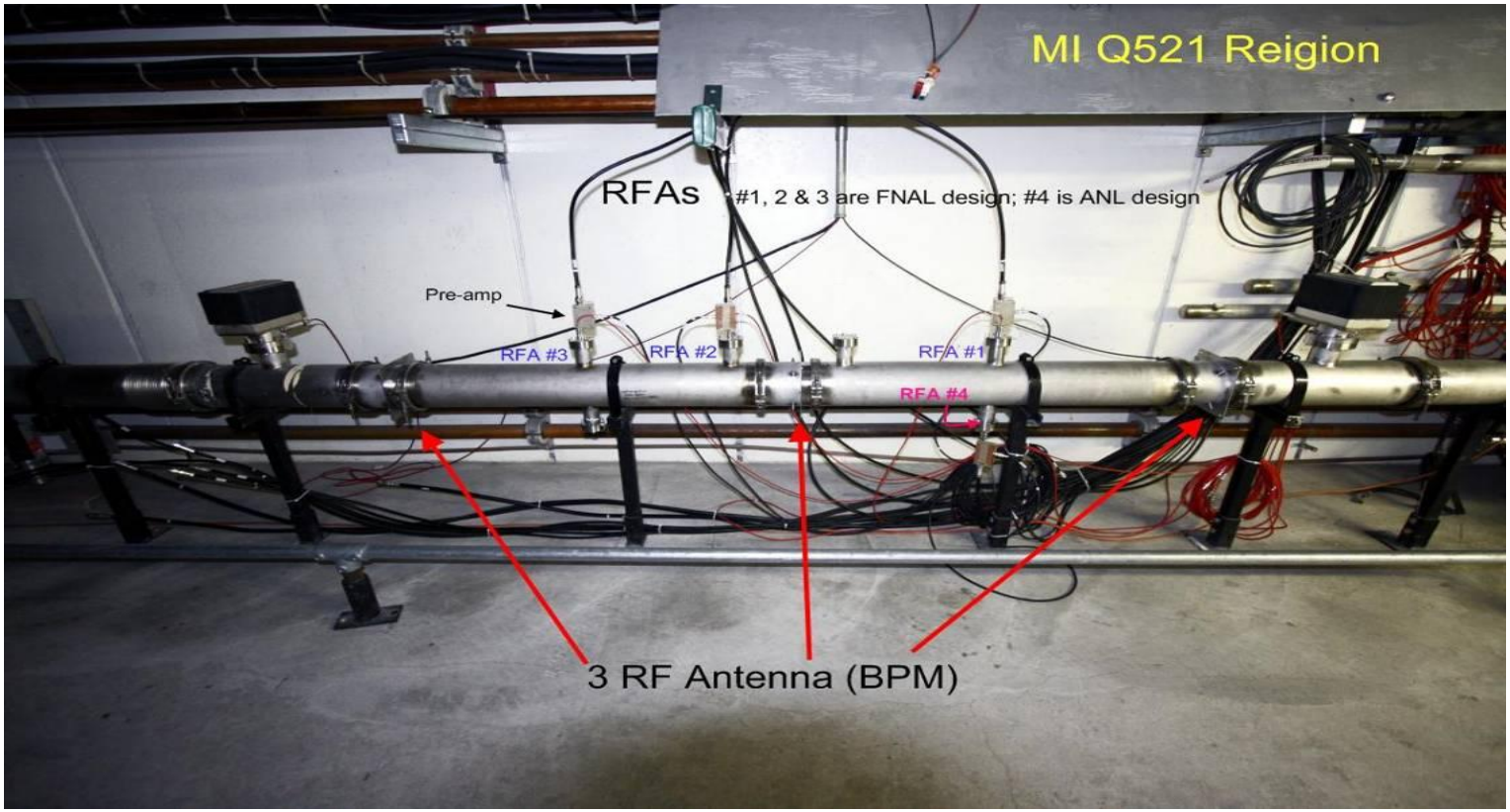
- Collaborated with BNL in coating with TiN two cylindrical 3ft beam pipes and installed one in MI.
  - An additional 10ft of cylindrical beam is going to be send for coating.

- We have developed a detailed plan with SLAC for the coating of a 20ft long elliptical beam pipe with hardware that can be used for in situ coating of the MI beam-pipe.
  - Work has started on fabricating parts.
  - Coating to start in mid October.

Project X Coating of MI beam pipes at BNL

L. Valerio

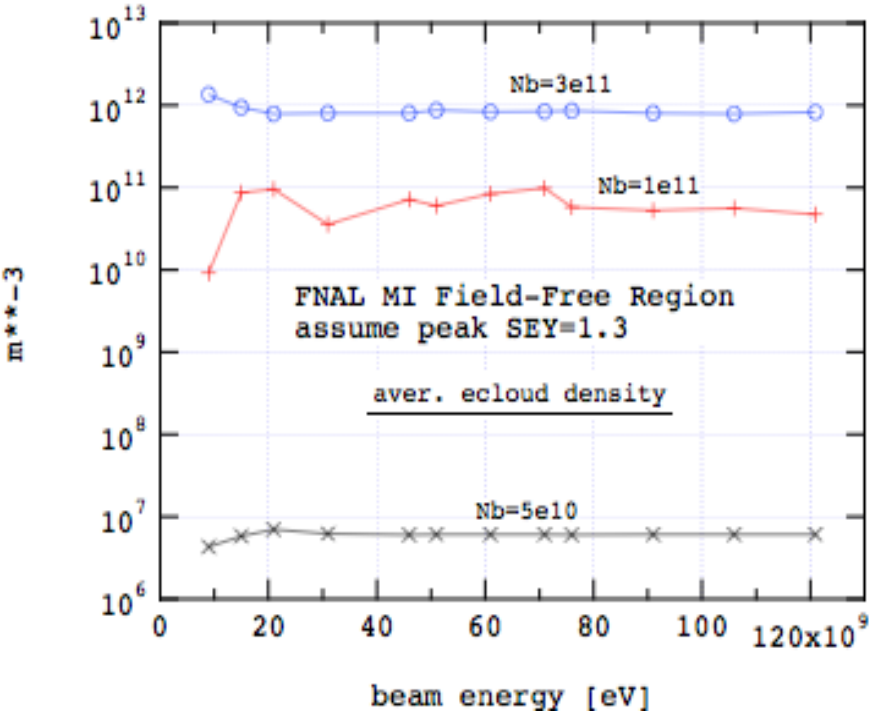
MI E-CLOUD TEST SET-UP AT MI-52

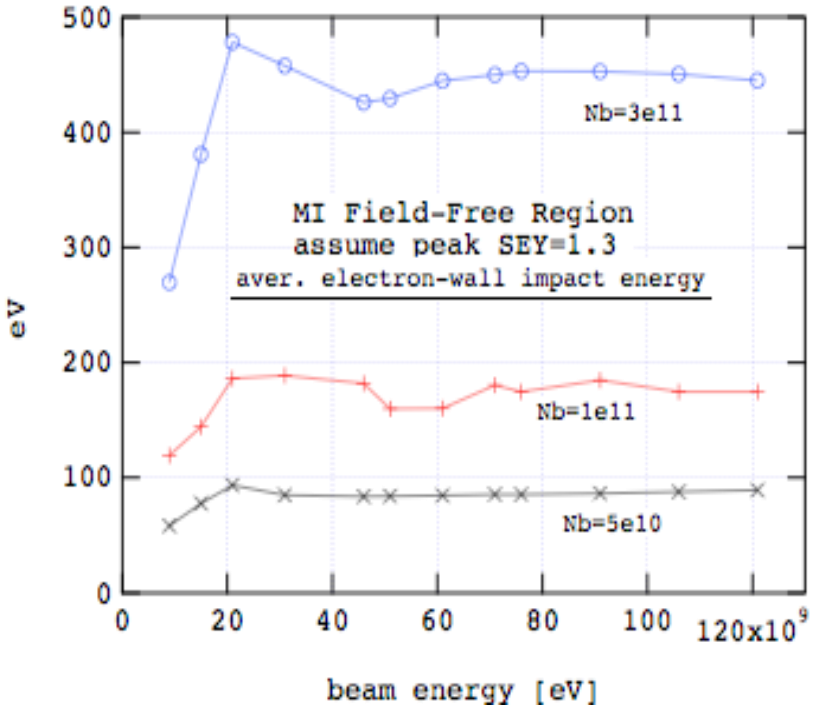


Recent progress (3)
E-Cloud simulations

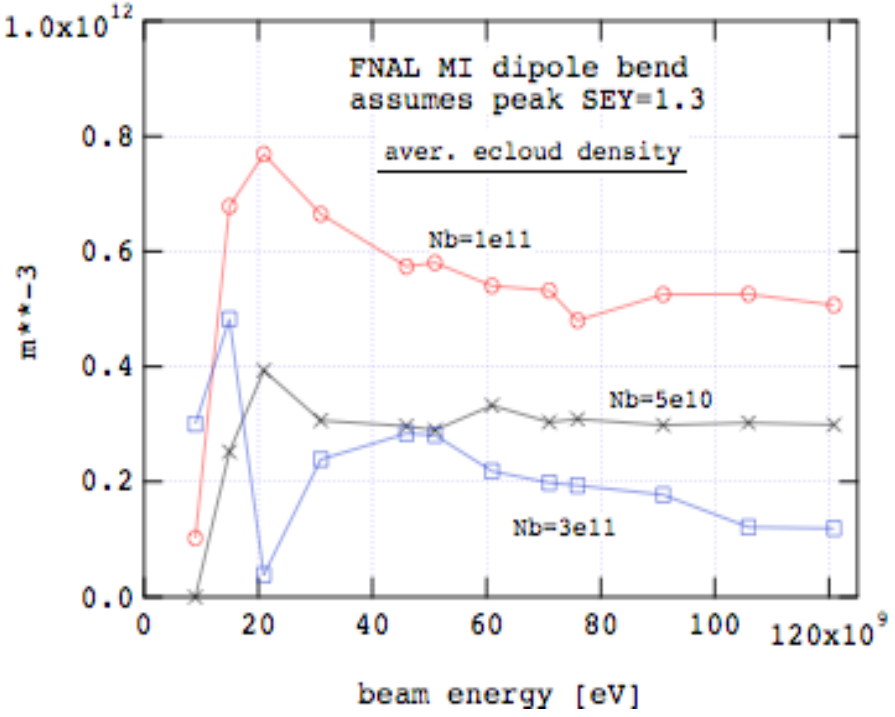
- Continued the e-cloud generation simulations with PONSIT.
  - Comparison with RFA data helped fix SEY.
  - Comparison of two rf frequencies.
  - Simulation results for both bend and straight sections.
  - Comparison between MI and PS2.
  - Results between bend and straight region look very different!

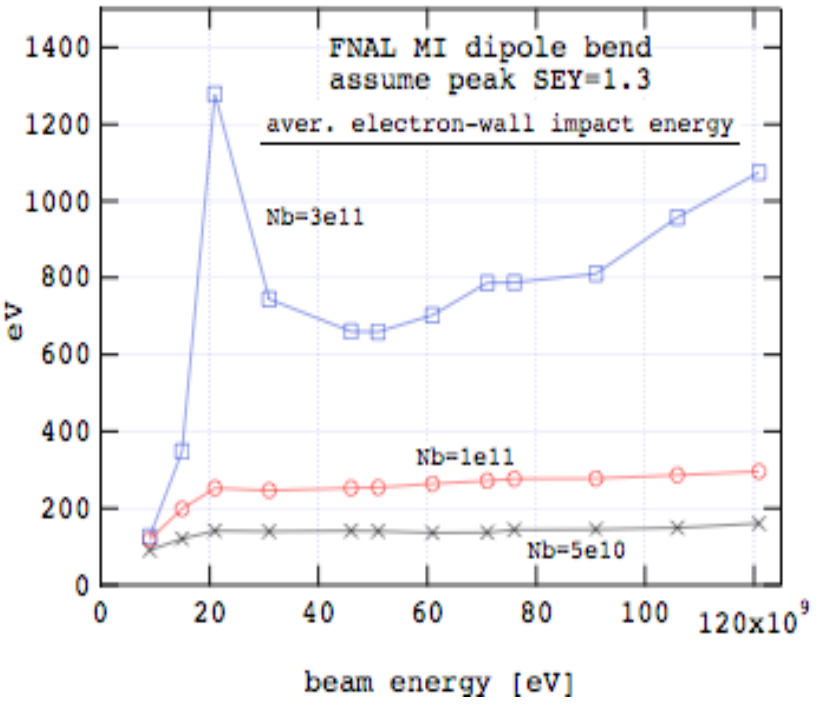
E-Cloud Simulation Results. Straight sections





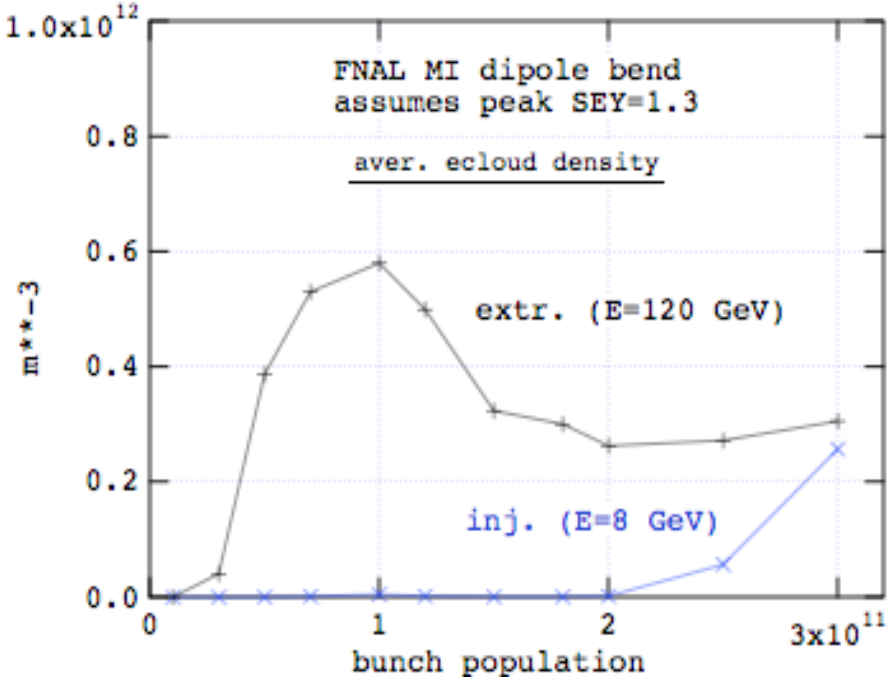
E-cloud simulation results for MI dipole region

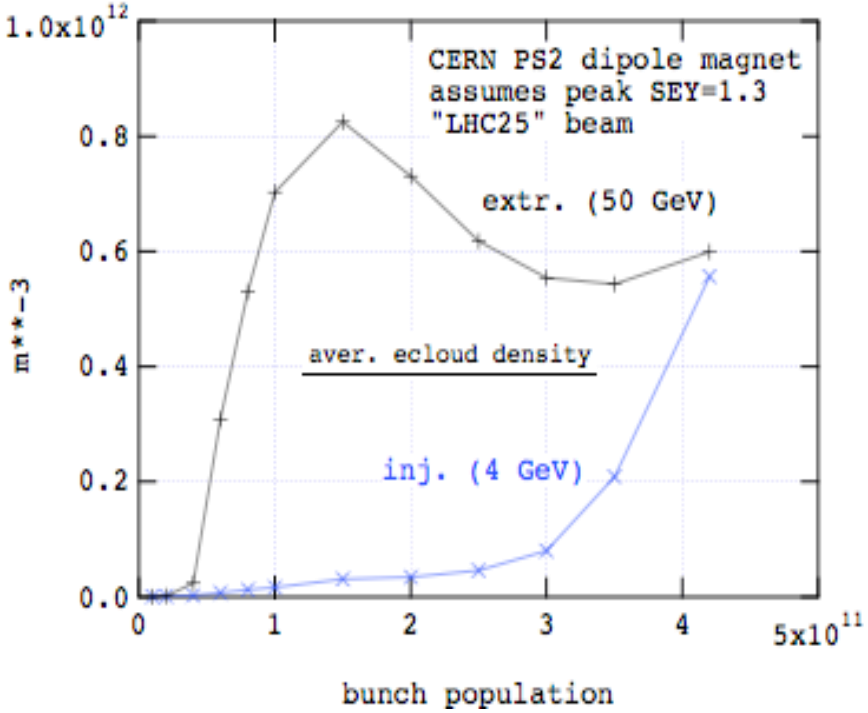




M. Furman

Project X Comparison between PS2 and MI

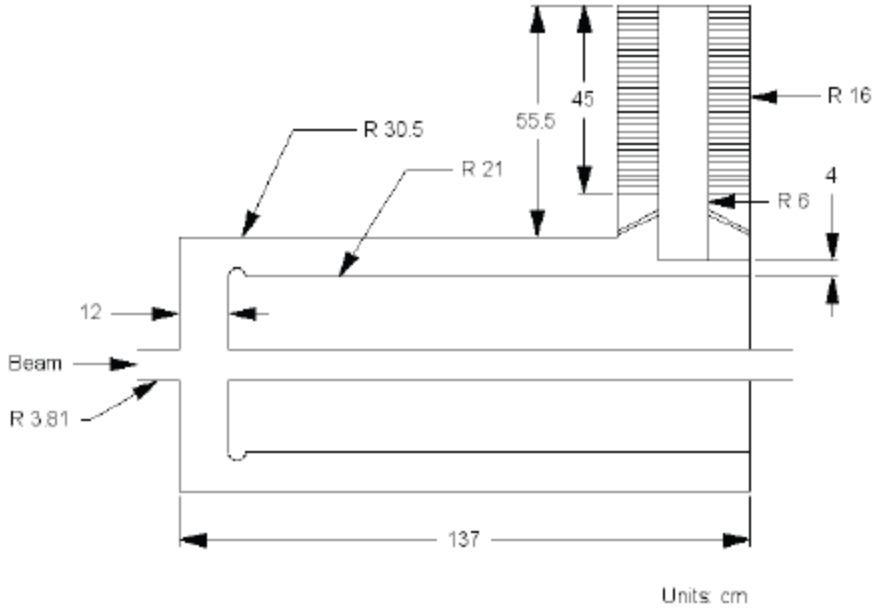




Recent Progress (4)New MI/RF System

- Developed a cavity design that meets all the requirements for the fundamental 53MHz rf system.
- Have identified a power tube that will work for both 53 and 106 MHz handle the currents required.
- Started work on a higher order mode damper.

New 53 MHz Cavity design and parameters



	Project X Collaboration 21-Nov-08 Design
Harmonic Number	588
Number of Filled Buckets	548
Frequency:	52.8114-53.104 MHz
Acceleration Ramp Slope:	240 GeV/s
Beam Intensity:	1.6e14 Protons
Beam Accelerating Power:	6.144 MW
Number of Accelerating Cavities:	18
Cavity R/Q:	25
Cavity Q:	4000
Accelerating Power per Cavity (beam):	450 kW/Cavity
Maximum cavity Accelerating Voltage:	300 kV/Cavity
Accelerating voltage required: $V\sin\phi_s$	2.66 MV
Total Accelerating Voltage Available:	5.4 MV
Total Peak Amplifier Power Required:(beam + cavity)	791.3 kW

J. Dey

Project X Tentative FY10 Plan (1)

- MI/RR RF
  - FNAL
    - Continue optimizing the cavity design.
    - Design a higher order mode damper.
    - Purchase one power tube and investigate mounting.
    - Make a cavity mock up for low power tests.
  - SLAC
    - Model the cavity design using the Omega3P parallel EM code.
  - ANL?
    - Work on modeling and mechanical design of the cavity tuner.

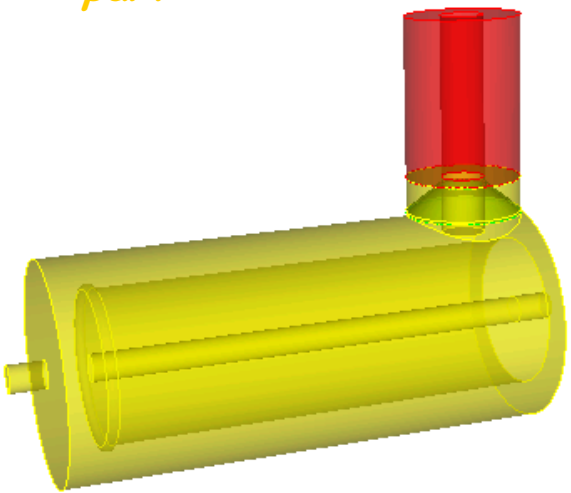
Simulation model of the MI Cavity with Omega3P code.

L. Xiao

Red: Ferrite

Green: Ceramic window

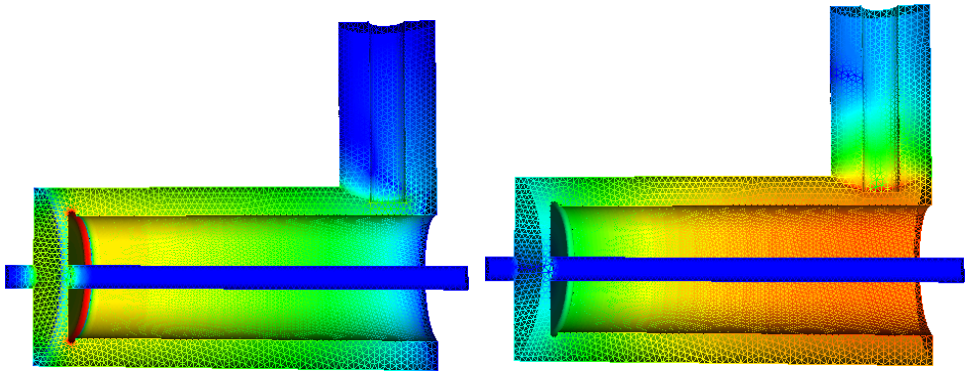
Yellow: Copper coated wall & Vacuum part



F = 53.701MHz

R/Q = 58.69 Ω (β=1)

Q0 = 9630 (σ=5.8e7 s/m)



E field B field

Project X Tentative FY1O Plan (2)

- E-Cloud Simulations
  - LBNL
    - Continue the PONSIT simulations and comparisons with beam data.
    - Start beam dynamics simulations
  - SLAC
    - Compare PONSIT results with CLOUDLAND?
- E-cloud Measurements
    - Compare the microwave results with the RFA for both coated and un-coated beam pipes.
    - Try and measure tune shifts of a target bunch.
- E-Cloud Mitigation

  Develop hardware for in-situ TiN coating in MI.
    - Set-up for beam-pipe coatings in Fermilab.
    - Follow the developments in alternative coatings (Participate in the CERN workshop on coatings)

Project X Tentative FY10 Plan (3)

- Start space charge simulations for MI using Synergia at Fermilab (E. Stern, J. Amundson) and Impact at LBNL (J. Qiang, R.Ryne). Both 3-d codes can include apertures for different elements and high order multi-poles for magnets.
  - Work on benchmarking the two codes.
  - Experimental validation of simulation results.
  - Apply simulation predictions to evaluate how much space charge tune shift we can tolerate, and what are the losses as a function of the bunching factor.
- Start a program of space charge studies in MI.
  - We can easily generate single bunches with intensities of 3E11!